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NPSI DPS 2.2

NAVAIR PORTABLE SOURCE INITIATIVE (NPSI) DATA PREPARATION STANDARD
(DPS)

Prepared For:

Common Simulation Products (CSP)
NAVAIR Aviation Training Systems PMA 205

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14. ABSTRACT
The mission of NPSI is to provide maximum database reuse across Type/Model/Series platforms to lower the life cycle cost of out-the-window visual terrain, 3-D models, and sensor databases, along with dataset archive capability, and short-notice distribution services. This document outlines the standards and requirements for data capture to meet the NPSI mission of data reuse.

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4/29/11	V2.1.9	*	Updated OpenFlight® versions, texture formats, and added paragraph clarifications.
5/22/2012	V2.2	*	Significant content re-organization. Added Interim datasets Adjusted License Language Added V&V checklists

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Acronym List

ANSI .... American National Standards Institute
AOI .... Area of Interest
CDB.................... Common Database
CDRL .... Contract Data Requirements List
CIB® .... Controlled Image Base®
COTS .... Commercial Off The Shelf
CSP .... Common Simulation Products
DBDD .... Database Design Document
DDS .... DirectDraw Surface (file format)
DFAD .... Digital Feature Analysis Data
DFARS .... Defense Federal Acquisition Regulation Supplement
DISR .... DoD IT Standards Registry
DoD.................... Department of Defence
DOF.................... Degrees of Freedom
DPS .... Data Preperation Standard
DTED .... Digital Terrain Elevation Data
DVD .... Digital Versatile Disc
ESRI .... Environmental Systems Research Institute
FACC .... Feature and Attribute Coding Catalog
FAR .... Federal Acquisition Regulation
FFD .... Foundation Feature Data
GB .... Gigabyte
GFI .... Government Furnished Information
GFP .... Government Furnished Property
GIS .... Geographic Information System
GeoTIFF .... Geographic Tagged Image File Format
ID .... Identification
IG .... Image Generator
IRS.................... Indian Remote Sensing
JPEG.................... Joint Photographic Experts Group (file format)
KML.................... Keyhole Markup Language (file format)
KMZ .... Keyhole Markup Language Zipped (file format)
LAT .... Lattitude
LIDAR .... Light Detection and Ranging
LOD.................... Level of Detail
LONG.................... Longitude
MIP .... Multum in Parvo "much in little"
MPRD .... Material Properties Reference Database

NAVAIR.....Naval Air Systems Command
NEC.....NSG Entity Catalog
NGA.....National Geospatial Intelligence Agency
NIST.....National Institute of Standards and Technology
NITF.....National Imagery Transmission Format (file format)
NPSI.....NAVAIR Portable Source Initative
NRE.....Non-Recuring Expenses
NSG.....National System for Geospatial Intelligence
OTW.....Out-the-Window
PMA.....Program Management Activity
QA.....Quality Assurance
RGB.....Red Green Blue (file format)
RGBA.....Red Green Blue Alpha (file format)
SEDRIS.....Synthetic Environment Data Representation and Interchange Specification
SME.....Subject Matter Expert
SOW.....Statement of Work
STF.....SEDRIS Transmittal Format (file format)
TIF.....GeoTIFF or TIFF (file format)
TIFF.....Tagged Image File Format
TIN.....Triangulated Irregular Network
USB.....Universal Serial Bus
UVMAP.....Urban Vector Map
VMAP.....Vector Map
VPF.....Vector Product Format
WGS.....World Geodetic System
XML.....Extensible Markup Language
XSD.....XML Schema Definition (file format)

1. Overview of NAVAIR Portable Source Initiative (NPSI)

NPSI is a simple concept with a simple goal to minimize the redundancy in database production across platforms without inhibiting innovation. The basic concept of NPSI is to capture value added work performed on raw source data. This concept has resulted in significant cost savings and increased efficiency of database production to many Department of Defense (DoD) programs by minimizing the purchase and processing of new source data required for future developments. The NPSI archive stores refined source data in datasets and makes the datasets available for utilization by future programs. However, unlike the refined source data, run-time databases are not stored in the archive. The visibility of data assets when new program requirements are defined and the utilization of the data archived by NPSI have allowed DoD programs to vastly expand their training gaming areas. NPSI creates new opportunities for programs and trainers by allowing programs to do more for less and sometimes faster than ever before. The functional diagram of the NPSI process is shown in Figure 1.

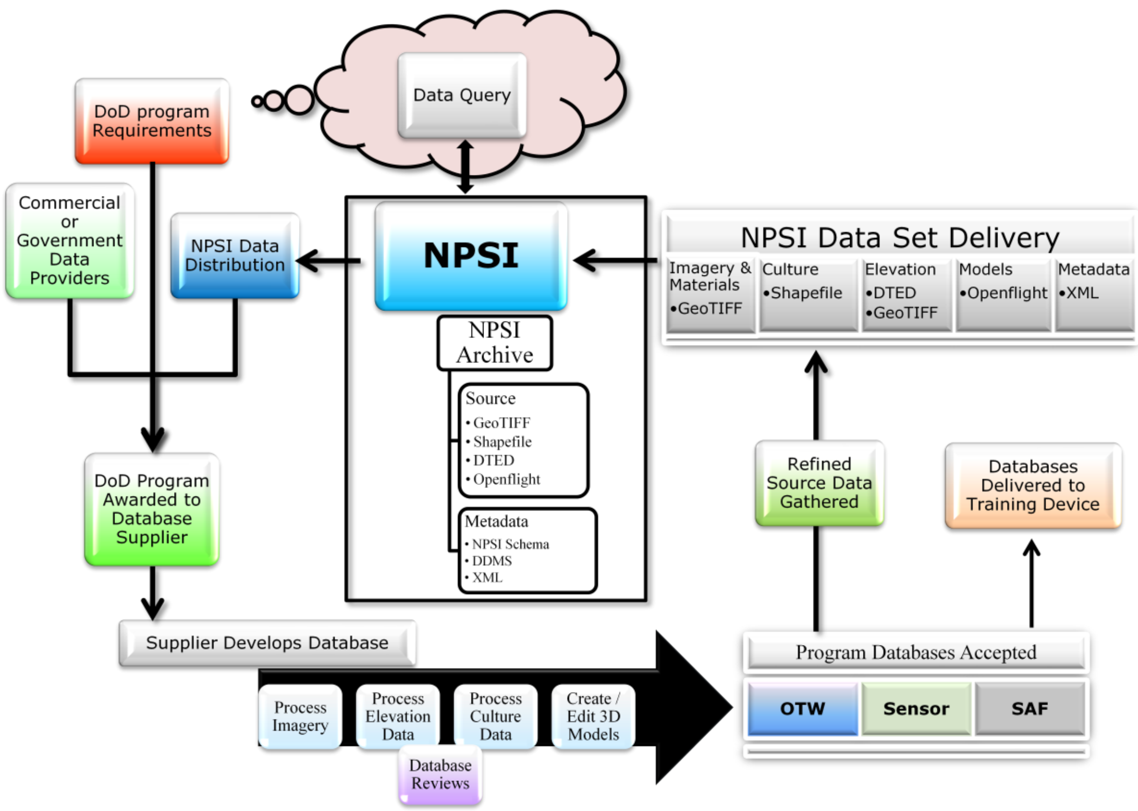

Figure 1 Functional diagram of NPSI process.

1.1 Definition of Overloaded Terms

Synthetic Environment: The synthetic environment is the overarching collection of databases produced to provide a training environment.

Dataset: A dataset is a collection of source data (e.g., imagery data, elevation data, shape files, 3-D models, etc.) required to produce a database.

Database: A database is an organized collection of data that is stored and ready to be read by another system typically in a proprietary format. The database is derived from a dataset.

Run-time database: A run-time database is the native, often proprietary, format the application reads to produce the synthetic environment. While not always the case, the run-time database is often considered read-only.

Raw source data: Raw source data is data that has not been processed for use. Raw source data products are typically acquired by a third party vendor and then delivered to the prime contractor or to the prime contractor's supplier to implement many of the corrections listed in section 4.2.

Refined source data: Refined source data is data that has been processed and corrected for use within specific applications. The corrections invested into the refined source data have significant value. By reuse of the refined source data, cost savings and efficiency can be achieved.

1.2 NPSI Concept of Operation

The mission of NPSI is to provide maximum database reuse across Type/Model/Series platforms to lower the life cycle cost of out-the-window (OTW) visual terrain, 3-D models, and sensor databases, along with dataset archive capability and short-notice distribution services. The functional diagram of the NPSI process is shown in Figure 1.

1.3 Need for NPSI

Databases have often been an expensive piece of training systems. Oftentimes, database development efforts are seen as a mix of artwork and engineering design. The costs of these databases results from both labor hours needed to refine data and from materials acquired in the database process. Unlike simulator hardware and software costs, which have decreased in the past decade, database costs have been stagnant. The greatest opportunity for optimization and cost savings in database designs is through increased efficiency and reuse. Without reuse, every time a new simulator is built, a new database must be built from scratch. A need for reuse can be shown when different programs have a similar database requirement in the same geographical area, but are separated by several years. In the past, each program would have created a custom Camp Pendleton each time at a cost of hundreds of thousands of dollars. These custom Camp Pendleton databases are almost exactly alike. In fact, the same requirements might have been used to build each database. The result is many months and many dollars spent to create each one individually. If the dataset was created only once and reused to create each follow-on database, then the future programs would have saved money and time instead of recreating the same database. In order to meet the DoD Directorate 5000.59 (Under Secretary of Defense (AT&L), August 8, 2007) emphasis on maximizing the commonality, reuse, and effectiveness of modeling and simulation data, a new model must be established.

Reuse can lead to greater efficiency in the beginning, middle and final stages of database development. Each stage has the potential to be the optimum single capture point. The single capture point would allow maximum reuse with the least amount of effort. The beginning stage is when the collection of raw source data is received from the suppliers. By utilizing source data from the beginning stage, time and cost savings are seen in the initial source data acquisition and collection tasks. However, capturing the data at the beginning phase would only yield savings on the acquisitions of the raw data products. These savings in cost are important but do not include the non-recurring expenses (NRE) of the development and processing done during the later stages. The middle stage contains the meat of the development process by correcting and processing the source data until it is ready for compilation into a run-time database. The name middle stage is misleading. Because, the middle stage often consumes significant labor and time. In some reports, up to 80% of the cost to produce the database is the result of the middle stage. The final stage or possible capture point is at the completion and acceptance of the run-time database. The product of the final stage is often in a proprietary format. Because of the proprietary format, reuse is hampered to the point of diminishing returns.

The NPSI team found that the best place to archive a product is after the middle stage is complete, where the source data is refined, correlated, and ready for processing. If data is captured at the end stage, reuse is extremely difficult due to proprietary formats. Likewise, the first stage only captures twenty to thirty percent of the database costs making this stage an underperforming location for a return on investment. At the discretion of the primary acquisition program, an interim delivery can be captured by the NPSI team after the first stage. In this case, programs on a parallel acquisition cycle could reuse the first stage data products.

While the optimum capture point is after the middle stage, the best and acceptable time to deliver the captured data products is after the acceptance of the run-time database. Once the run-time database is completed, and the results of the database are acceptable, the source data used to create the database can be captured and archived. Data deemed acceptable in the past can now be reused with a high level of confidence that the archived data will be of value to other programs. The issue in this approach is the case of parallel or partially parallel programs effort that are enhancing similar areas. In this case, the expansion of the interim datasets option will maximize the effectiveness of NPSI.

The functional diagram in Figure 1 illustrates the flow of data, requirements, and products in a typical NPSI database production process. Appendix A and Appendix B provide more detail into the processes involved in the development of an NPSI dataset and completion of a run-time database.

2. NPSI Dataset Description

An NPSI dataset contains the combination of refined source data, metadata descriptions, and data license information. The dataset will include several different industry standard data types. By focusing on well-used and well-documented industry standards, maximum availability and reuse can be achieved without significant cost burden to the program.

Licenses and markings are provided by the contractor for new data acquisitions allowing visibility of ownership and direct contact to the specific vendor in the case that data is in need of future licensing expansion or uplift. Both data licenses and data legacy are annotated within the NPSI metadata documentation. The following paragraphs are high-level descriptions of the key elements within an NPSI dataset, while the requirements for an NPSI dataset is located in section 4.

2.1 Dataset Data Types

The following sections describe the typical components of an NPSI dataset. While a dataset may not contain all of the data types listed, the goal of NPSI is to archive a dataset(s) that accurately represents the source data required to recreate the program's run-time database(s).

2.1.1 Terrain Data

Terrain data, or elevation data, is a grid of elevation posts at specific intervals indicating the height of the terrain at each post. The mosaic of these terrain data files is a representation of the earth's surface. Refined terrain data can hold several corrections including spike minimizations and hole interpolations. The refined terrain data can be a merge of several different terrain data collections. The terrain skin created from the terrain data is one of the critical pieces of correlation used in ground simulation. Significant labor efforts are involved in terrain correlation. The archival and reuse of terrain data is a key first step to better-correlated database products. Depending on the data's source, resolution, and refinements, the terrain data is delivered in different standard formats.

2.1.2 Feature Data

Feature data represents geographic data using constructive geometric primitives such as point, linear (line), and areal (polygon) that are to be integrated or overlaid on the terrain skin. Refined feature data includes any adjustment and/or additions that have been made to the original source data to provide better correlation with imagery or other source data. The National System for Geospatial Intelligence (NSG) Entity Catalog (NEC) attribution is desired as the default attribution schema.

2.1.3 Imagery Data

Imagery is defined by U.S. Code Title 10, §467 as:

> The term "imagery" means, except as provided in subparagraph (B), a likeness or presentation of any natural or manmade feature or related object or activity and the positional data acquired at the same time the likeness or representation was acquired, including - (i) products produced by space-based national intelligence reconnaissance systems; and (ii) likenesses or presentations produced by satellites, airborne platforms, unmanned aerial vehicles, or other similar means. (B) Such term does not include handheld or clandestine photography taken by or on behalf of human intelligence collection organizations.

Imagery data provided in an NPSI dataset is the refined version of that imagery with any source data redundancies resolved. The data represents, at a minimum, the fidelity and resolution delivered for the application and platform. However, it is desired that the imagery be delivered at the highest resolution of the refined source data, and not an under sampled image of less resolution.

2.1.4 Raster Material Analysis Data

A sensor simulation database often requires the analysis of raster imagery in multiple bands to discern the material type. The raster material analysis data is often stored and labeled as a material map. Material maps denoting a type or mixture of types, on a per-pixel basis, can be created by third party tools and saved into an image file for future use. The material map must have a reference document included to describe the meaning of each pixel value within the material map. The material data references in an NPSI dataset are described in the metadata Section 2.1.8 below.

A material properties database is populated with authoritative reference documents and is expandable to include supplemented authoritative data in the future. The desire to form a common standard by utilizing the Material Properties Reference Database (MPRD) Schema is common among other DoD training commands. A standard material library is essential for addressing issues of interoperability and validation of a sensor model.

2.1.5 3D Static Models

3D static models can be generic models that are planted at fixed locations either randomly or by structured order. The generic models could include a typical office building, a church, or a power line tower. 3D static models can also be specific models captured and placed to represent specific features at specific places, such as the Statue of Liberty.

The dataset often includes any alternate versions of the models, the levels of detail (LODs), associated texture maps, animation controls, and articulated parts. that are necessary to incorporate the model into follow-on applications. The 3D model often includes geospatially referenced footprint polygons. The model origin point is the (0,0) point within the 3D model. The model origin point and/or footprint area for each one of the 3D static models are often represented as geospatial feature data files. The origin point can also be within the header of the model file itself. Other embedded feature data attributes of the 3D static models include the disk file name, relative directory location, model orientation, classification code, and a name or label.

2.1.6 3D Moving Models

3D moving models are often seen in the visual scene as entities such as planes, tanks, ships, and people. The dataset would include alternate versions of the models such as differing paint schemes and damaged states, as well as articulations, animation controls, LODs, and switches.

2.1.7 3D Airfield Models

Airfields are considered rather large 3D static models. The size of an airfield imposes new modeling considerations to be taken into account when the airfield is developed. Airfields are often subject to projection errors when converting between projections and datums of runtime systems. Therefore, great care must be taken when attributing and referencing a 3D airfield. If multiple files are used to represent an airfield, it is common to have an airfield master file to externally reference all other 3D model files built for the airfield.

While not all systems support the OpenFlight® file format natively, the format has become a significant standard within the industry. Therefore, examples of OpenFlight® airport hierarchy and structure recommendations are presented in Appendix C and recommended light point naming conventions are shown in Appendix D.

2.1.8 NPSI Metadata

An extensible markup language (XML) metadata file accompanies each NPSI dataset distribution. The schema of this metadata is defined in the following document, *NAVAIR Portable Source Initiative Standard for Reusable Source Dataset Metadata V2.4*. NPSI metadata is an overall wrapper of the NPSI dataset providing descriptions of all files included within the dataset in a single XML file. Licensing and security classification elements are present at both the dataset and the individual file element level allowing an accurate description of both individual files and the overarching dataset. The location of the data files and thumbnails are identified within the file elements enabling the metadata file to map smoothly into a catalog system. Data groups associate similar file elements together within the dataset description.

The NPSI metadata references material properties using a lookup index to the MPRD data files. The material data file XML format is defined in the *NAVAIR Portable Source Initiative Standard for Material Properties Reference Database V2.2*. MPRD schema and is an extension of Material Markup Language (MatML). MatML was a National Institute of Standards and Technology (NIST) initiative supported by a community of materials engineers and scientists. MPRD supports multi-spectral radiometry properties and multi-component materials.

2.2 NPSI Dataset Acceptance

The content of the NPSI dataset will be tested and evaluated for completeness and accuracy by the NPSI team. The primary criterion for evaluation is verification that the dataset sufficiently supports the development of follow-on databases with a minimum of redundant efforts. Further information on requirements can be found in Section 4 and Section 6. Interim datasets, as described in Section 4.3, will be verified for geospatial coordinates, license information, and an accurate file list. Unlike final NPSI datasets, interim datasets do not require NPSI formatted metadata.

2.3 NPSI Dataset Distribution

Once the NPSI dataset is accepted, the NPSI data will be ready for distribution to future programs. The government will determine the NPSI dataset components that are to be provided as government furnished information (GFI) to the program, and the selected data will be delivered to the supplier(s) in accordance with the Federal Acquisition Regulations (FAR) government furnished property (GFP) clauses and the contract GFI and GFP clauses.

The program’s database requirements (e.g., airfields, targets) are presented in the statement of work (SOW) and specification. Likewise, requirements for interoperable correlation are presented in the SOW and specification of the contracted effort. Regardless of the NPSI dataset distributed and received, the correlation, fidelity, and coverage requirements for the production and development of the database per the contract remain the supplier’s responsibility. Database suppliers are required to meet the requirements specified within the contract regardless of GFI or GFP quality. In these cases, additional data can be procured or created by the contractor to meet the requirements of the contract.

3. Follow On Database Production

Follow on database suppliers have tool sets in place (commercial off the shelf (COTS) and/or proprietary) that can utilize the data formats incorporated into NPSI datasets. The database production process is similar to that described in Appendix A. The database developed from the NPSI data is optimized to support the specific aircraft missions and maneuvers. The content of the database is sized and structured for optimum performance.

3.1 Dataset Reuse

In many cases, even reused datasets require some development effort. Programs that limit database production to pure reuse of an NPSI dataset essentially accept the previous programs requirements with respect to fidelity, gaming areas, and culture data. If a prior program produced a database description document (DBDD) then the DBDD can be provided as a description of the prior program requirements and extents. A process similar to the original acceptance process will be used to accept the database created from the reused dataset. The follow-on supplier is expected to verify that the database is sufficiently interoperable with previous databases. The NPSI dataset and the run-time database are tested for performance in a networked or standalone environment based on the requirements of the contract. If there were no modifications or additions of refined source data to the dataset then there is no need for an NPSI delivery back to the archive. In these cases, the contract data requirements list (CDRL) for NPSI delivery should be marked as an option.

3.2 Possible NPSI Feedback and/or Extensions

There is a possibility that subsequent database efforts will require the addition of a new data type(s) within an NPSI dataset and expanded descriptions within the NPSI DPS. This request may result if new forms of data have become available since the creation of the original NPSI dataset (e.g., technology enhancements, improved imagery formats, material encoded texture maps, etc.). As with the original philosophy of NPSI, it is important to capture the work done and new data types available for future reuse. Incorporating this new data so that the development efforts are not repeated on subsequent efforts provides cost savings to future programs.

Upon determining that additional data type(s) are required within the dataset archive, the supplier shall notify the government manager of the NPSI data archive for consideration. Incorporating additional data type(s) into the NPSI DPS and the NPSI archive will be determined based on the data type(s) involved. A determination will be made by the NPSI team to add the new data type(s), replace previous data (again depending on the nature of the new data type(s)), or deny the request to store the new data type(s). The NPSI DPS will also be updated to include any information that will make it easier for subsequent suppliers to make use of the data.

4. NPSI Dataset Requirements and Components

The purpose of the NPSI standardization is to lower the total life cycle cost, to encourage interoperability, and to open simulation device architecture. NPSI will standardize on common data formats utilized by industry rather than developing a new data format. By adhering to the open architecture strategy described below, NAVAIR will not be forced to use a single source throughout the life cycle of the program.

All data shall have the data license rights, all limitations associated with the data, and the contractor point of contact identified and documented. The documented data shall be stored in a text document at the root of the dataset folder, documented in the NPSI metadata, and marked on the physical media as part of the NPSI dataset delivery.

For all GFI data, the documentation shall reference GFI source data lineage. The NPSI dataset(s) delivery is in addition to the run-time database(s). It is desirable for these two items to be delivered against the same CDRL. However, this will be determined by the contract.

The contract is desired to have the following DFARS clauses attached, 252.227-7013, 252.227-7015, 252.227-7022, 252.227-7025, and 252.227-7037, however, each contract should be evaluated for applicability of each clause.

4.1 NPSI Dataset

All refined source data required to re-create the delivered run-time databases (e.g. visual, sensor, semi-automated forces, etc.) shall be delivered to the NPSI archive as a compliant NPSI dataset. All NPSI data shall have a GEOGRAPHIC (UNPROJECTED) LAT/LONG projection and World Geodetic System (WGS)-84 datum. The data within the NPSI dataset shall be delivered in the following formats:

Terrain:	Digital Terrain Elevation Data (DTED) format (National Imagery and Mapping Agency, 2000), or lossless GeoTIFF (Ritter & Ruth, 2000) in 8-bit, 16-bit, or 32-bit in signed integer, or floating-point gridded matrix intensity map.
Features:	ESRI® Shapefile format (Environmental Systems Research Institute, Inc, 1998).
Imagery:	Lossless GeoTIFF format (Ritter & Ruth, 2000): 8-bit, or 16-bit, unsigned integer pixel representation.
Raster Material Data:	Lossless GeoTIFF format (Ritter & Ruth, 2000): 8-bit, or 16-bit, unsigned integer pixel representation.
Models and Airfields:	OpenFlight® (Presagis, 2009) version 16.0 (or later) with RGB, RGBA, JPEG, DDS, DXTn, FXTn, or TIF textures.

Media Type (Delivery):	DVD or External Hard Drive with USB or eSATA interface. USB3.0 is desired. Media shall be marked with distribution rights and license type.

4.2 Raw Source Data Examples

- DTED: level 1, 2, 3, 4, or 5
- Light detection and ranging (LIDAR) point cloud data
- Controlled Image Base®: CIB® 1, 5, 10
- National Imagery Transmission Format (NITF) data received from National Geospatial Intelligence Agency (NGA)
- Commercial satellite image library products:
    - Ikonos panchromatic and multispectral
    - GeoEye panchromatic and multi-spectral
    - Quickbird panchromatic and multi-spectral
    - WorldView1 panchromatic and multi-spectral
    - WorldView2 panchromatic and multi-spectral
    - RapidEye
    - Indian Remote Sensing (IRS)
    - Spot
    - LandSat
- Aerial photography data from various vendors
- Foundation Feature Data (FFD), Digital Feature Analysis Data (DFAD), Vector Map (VMAP), Urban Vector Map (UVMAP)
- Vector Product Format (VPF)
- TopScene Data in open image formats such as GeoTIFF and NITF
- NPSI archived producer level data (raw)
- NPSI interim datasets (raw)
- SEDRIS Transmittal Format (STF), which can be converted using core SEDRIS tools or COTS vendor toolsets

4.3 NPSI Interim Datasets

All raw source data, as listed in section 4.2, that is purchased by the contractor team for the program is considered an interim dataset. For interim datasets cumulatively valued over $50,000.00, early delivery to NPSI is requested. Interim datasets will be stored within the NPSI archive until the official NPSI dataset(s) delivery from the program is received. At that time, the interim dataset will be permanently backed up to media and will no longer be an actively searchable or distributable dataset unless specifically requested. If interim datasets are anticipated, individual CDRLs or CLINs will be utilized to purchase the data, enabling other government programs to make use of the raw source data upon receipt.

4.4 Open Source Data Preparation Components

The preparation of source data accounts for a significant effort in the generation of a run-time geo-specific database. Correlation is a historical problem with source data, including NGA products mentioned in Section 4.2 above. The following labor-intensive processes address these issues and can be performed using third party tools. By requiring the following processes for standardization, the government can more readily reuse the product of a dataset delivery. It is important to discriminate which processes are to be done only once and which processes are best done on a per run-time database publication occurrence. The following sections describe processes done only once resulting in data that is subsequently reused.

4.4.1 Terrain

4.4.1.1 Terrain Merge

Merging the terrain between different resolutions allows the simulation to have the most realistic terrain simulation. Familiarization of a given area is often done based on the appearance of the terrain features. While the terrain data most used in Navy simulation varies with each training device, every pilot requests, and in many cases demands, increased fidelity and realism. Terrain merge is the method of taking a base elevation, such as DTED 2 representing 30-meter elevation post intervals, and merging with a high fidelity elevation, such as LIDAR representing 1-meter elevation post spacing. The final product will have high fidelity elevation data in the area of interest and a lower fidelity background. Terrain merge shall be performed as required and any changes shall be captured in the formats described in Section 4.1.

4.4.1.2 Terrain Edits

Edits to terrain data may include flattening the terrain for lakes, correlating terrain to rivers, incorporating cut and fill for roads, smoothing spikes and holes, or correcting the underlying source data that mismatches between the boundaries of files. Terrain edits performed shall be captured in the formats described in Section 4.1. For these edits, it is also requested that the original elevation data also be provided.

4.4.2 Features

Vector products such as DFAD and VMAP designate point, linear, and areal features. These vector representations typically do not match imagery, and the work associated with correlating features to the imagery is labor-intensive. Corrections are made to source data in applications that map features with imagery. Modifications made to feature data shall be saved in ESRI® Shapefile format with GEOGRAPHIC (UNPROJECTED) LAT/LONG projection and WGS-84 datum for follow-on programs. Terrain-feature correlation shall be performed as required.

DoD Information Technology Standards and Profile Registry (DISR) provide standards for Geospatial data. One such standard for attribution is the NEC (National System for Geospatial Intelligence, 2009) attribution standard. NEC attribution is desired to allow common identification of feature data.

4.4.3 Imagery

4.4.3.1 Ortho-Rectification

Imagery may need to be ortho-rectified, a correction that accounts for relief displacement and distortions caused by the terrain. Ortho-rectification shall be performed as required by the contract.

4.4.3.2 Image Rectification

Image rectification warps an image to match control points. This process addresses geometric inaccuracies such as a road in one image that is not geometrically continuous with the same road in an adjoining photograph. Image rectification shall be performed as required by the contract.

4.4.3.3 Image Normalization and Color Balancing

Color discontinuities are often observed in photographs taken at different times and can be a distraction in training. Image normalization is the process of evening out the brightness within individual images. Color balancing is the process of applying tonal and contrast adjustments to increase color consistency over the range of the photographs or images. Image normalization and color balancing shall be performed as required by the contract.

4.4.3.4 Imagery Merge

Oftentimes, source imagery comes in two separate files: a high-resolution panchromatic image, and a lower resolution multi-spectral image. These two images shall be merged into one image prior to ingestion into a run-time database generation system. Imagery merge shall not be done when the resolution ratio exceeds 6:1. NPSI delivery of imagery data before an imagery merge is not required.

4.4.3.5 Feathering

When inserting high-resolution imagery into an area of lower resolution imagery, a smoothing algorithm for feathering boundaries is often used to avoid a sharp, high-contrast line where one image ends and another begins. If feathering was completed, then the feathered images shall be delivered, and final pre-feathered images shall be delivered if available.

4.4.3.6 Image Masks

Mask files can be used to feather or blend data files together. The image mask consists of a single layer image that allows for gradient blending of the top image with the background images. This method is capable of removing discrepancies with the top image and replacing the data in a more dynamic approach allowing future modification without extensive reprocessing. If image masks were used, then the image masks shall be delivered.

4.4.3.7 Imagery File Size

There is a known file size limitation of 2 GB for GeoTIFF files. In the event an image file exceeds this limit, the image shall be broken into several tiles under the size limit. Image files shall remain uncompressed resulting in a lossless data capture.

4.4.4 Raster Material Data

Multi-layer raster material data constructed as material maps shall be included in the NPSI dataset. The material layers and the mixture layers shall be delivered merged into a single image file. The pixel values within the material layer shall represent a single material. The pixel values within the mixture layers represent the percentage of coverage of the associated material layer. For every two material layers one mixture layer is required.

If new references are used or old references are requested to be updated then those new metadata files shall be included in the NPSI dataset. The NPSI material library in XML format is defined in the NPSI MPRD per section 2.1.8 above. Therefore, all reference document(s) provided with the NPSI dataset shall be provided in XML format and validated against the MPRD Schema.

4.4.5 3D Static Feature Models

3D static feature models are either built from scratch, reused, or modified. In the case the 3D models are anticipated to be reused, additional training-relevant data may be necessary to meet the fidelity specified within the contract.

3D static feature models shall be delivered as required. All geospecific models must have defined the origin of the model, the current projection, and datum within the OpenFlight® Header. The models in the simulation-prepared source data shall be in OpenFlight® version 16.0 (or later) at all modeled levels of detail and states. The model origin point and/or footprint area for each one of the 3D static models shall be represented geospatially in the formats of feature data. Feature data descriptions of the 3D static models shall include, as attributes, the disk file name, the relative directory location, and the model orientation.

All textures associated with a single model shall have the same relative path and shall be included in the dataset. All sensor textures associated with a single model shall be included in the dataset. Sensor textures are desired to have the name exactly match the equivalent regular texture with the inclusion of '.sensor' in the name (e.g., door.rgb and door.sensor.rgb). Unused textures shall be removed from the model's texture palette and texture directory. All textures shall be formatted in compliance with section 4.1 and have a size that is a power of 2 in each dimension. Model(s) shall be facing in the positive Y direction. All empty nodes shall be removed.

4.4.6 3D Moving Models

3D moving models are either built from scratch, reused, or modified. In the case the 3D models are anticipated to be reused, additional training-relevant data may be necessary to meet the fidelity specified within the contract.

3D moving models shall be delivered as required. The models in the simulation-prepared source data shall be in OpenFlight® version 16.0 (or later) at all modeled levels of detail and states. The OpenFlight® model shall function properly as an OpenFlight® model. If extracted into OpenFlight® from an alternate format, the OpenFlight® model shall be verified for correctness, which includes all aspects of the model including lights and articulated parts.

All textures for a model shall have the same relative path and be included in the dataset. External referenced models shall have the textures relative to the referenced model. All sensor textures shall be included and it is desired to have the name exactly match the equivalent regular texture with the inclusion of '.sensor' in the name (e.g., door.rgb and door.sensor.rgb). Unused textures shall be removed from the model's texture palette and texture directory. All textures shall be formatted in compliance with Section 4.1 and have a size that is a power of 2 in each dimension. Model(s) shall be facing in the positive Y direction. All empty nodes are removed.

4.4.7 3D Airfield Models

All 3D airfield complex models are either built from scratch, reused, or modified. In the case the 3D airfield models are anticipated to be reused, additional training relevant data may be necessary to meet the fidelity specified within the contract. Airfield models shall be included as 3D static feature models per Section 4.4.5, described above, in OpenFlight® format version 16.0 or higher with all LODs, texture maps, animation controls, and articulations. All runway markings shall be prepared and stored under separate object or group nodes. Runway markings shall not be "cut in." Airfield light points reference the light point palette and the name or appearance of given light type is desired to be as descriptive as possible as shown in Figure 5, (see Appendix C.3).

While modeling techniques are not dictated, airfield complexes are to be modeled in such a way as to simplify segregation and desegregation of all features. At a minimum, each feature type is contained under an appropriately named parent group node.

It is recommended that each feature be modeled individually with its own origin and externally referenced and positioned into a master file, including but not limited to the following: runways and tarmacs with markings, foot to go markings, lighting systems, buildings, towers, and beacons.

The airfield shapefile shall reference each model with a separate point feature. Each point feature shall use either "file" or "code" as the index tag and the filename in the data field. Each shapefile shall conform to Section 4.4.2 requirements.

5. Deliverables

5.1 NPSI Dataset

When the run-time database is finalized and accepted, the initial supplier shall provide the final NPSI dataset(s) within **four weeks** unless specifically stated otherwise within the contract. All value-added source data used to produce the run-time database(s) shall be delivered in formats as referenced in Section 4.1. These delivery items shall be consistent with the vendor independent output processes described in Section 2.

5.2 NPSI Interim Dataset

The interim dataset shall be delivered within **two weeks** of delivery receipt and factory acceptance of the COTS or Non-COTS raw source data. The interim dataset shall include a copy of the procurement and usage license agreement. NPSI metadata is desired but not required with the interim dataset.

5.3 Documentation

An NPSI metadata document shall be provided for each dataset per Section 2.1.8. If the DBDD is developed, available, and delivered to the program then the DBDD shall be included with the NPSI dataset. The data licenses from the contractor for the new (non-GFI) data within the dataset shall be provided, in accordance with DFARS clause 252.227-7013, and referenced by the NPSI Metadata documents identified in Section 2.1.8.

6. Verification & Validation

The NPSI team will verify that all data delivered includes the value-added components. The program's visual subject matter expert (SME) is responsible to validate the correlation of the dataset and the run-time database. The NPSI team estimates two weeks to review each dataset. However, the exact review time allowed will be described within the contract's CDRL.

The NPSI verification and validation process shall be used to verify the NPSI data is in the required formats and can be ingested into the database generation system if delivered as part of the contract. The verification will reference documentation from the contractor such as the DBDD that describes the data, and the process used to output the NPSI data. The NPSI team will test the validity of the NPSI metadata. The testing will validate if the metadata accurately represents the dataset on the disk. Below are the current criteria questions asked with regard to dataset verification and validation. The tools listed are for explanation purposes only and do not reflect a requirement for the said tools.

6.1 Metadata

6.2Requirement	6.3Result
Is the metadata valid against the current NPSI schema file (*.xsd)?	Yes/No
Are the files listed in the metadata provided on the disk?	Yes/No
Are the files listed on the disk provided in the metadata?	Yes/No

6.3.1 Metadata Sample Validation Procedure

Step	Action	Procedure and Notes
1	Validate provided metadata file against given schema file (xsd).	Open the xml file and then associate the xml file to the schema (xsd).
2	Validate delivered metadata (xml) against current NPSI schema (xsd).	Validate contractual requirement. If the provided xsd file is the current NPSI xsd then skip to 3. Otherwise, the file must be remapped into the current NPSI schema format. After translation, validate the metadata.
3	Ingest the metadata into the NPSI catalog.	Open the NPSI catalog and test the connection to the server. Select the file to be ingested and start ingest. When complete, view the dataset by selecting the dataset ID and inspect the catalog entries to verify the data was successfully ingested into the database.

4	Run the quality assurance (QA) tool.	Using the Dataset QA tool, select the dataset ID to be checked and then select "QA Task". Confirm that the following QA options are checked: Check bounding coordinates consistencies, Check for all mandated XML fields, Validate file path, Get companion files, and Calculate transfer size. Then, select "Start QA".
5	Create separate outlines of the metadata.	Select the correct dataset ID and use the publish KML tool to export KML and KMZ outlines for each data type.
6	Do tasks on the other validation items [imagery, elevation, materials, shapes] then return.	Proceed to the imagery, elevation, materials, and shapefiles procedures and then return here.
7	Verify continuity in Google Earth or ESRI® GIS Globe tool.	Typical colors used for KML or KMZ output: • 16m (and above) = Green (0,170,0) • 8m = Yellow (255,255,0) • 4m = Orange (255,170,0) • 2m = Red (255, 0, 0) • 1m = Deep Red (170,0,0) • 0.5m = Dark Gray/Brown (125,60,0) • 0.25m = White (255,255,255) • 1 ft or less = White (255,255,255)

6.4 General Geospatial Information

Requirement	Result
Verify all files have a projection of geographic (unprojected) latitude and longitude.	Yes/No
Verify all files have a datum of WGS84.	Yes/No
Does the resolution of the data match the filename, folder and/or metadata description?	Yes/No

6.4.1 General Geospatial Information Sample Procedure

Step	Action	Procedure and Notes
1	Verify projection and datum.	In ArcMap use python scripts to do data verification on all directories and sub directories for all *.tif, *.shp, and *.dt# files
2	Verify Resolution with respect to the folder or file name.	Using the output of the first script, in ArcMap run a second script analyzing the calculated resolution against the folder name. Repeat with file name instead of folder name and

		analyze the results.

6.5 Imagery

Requirement	Result
Does the metadata match the image data provided?	Yes/No
Are all image files continuous?	Yes/No
Are the images color balanced?	Yes/No
Are different seasons present as overlapping areas?	Yes/No
Are the images blended?	Yes/No
If the images are not blended, does each image provide a blend mask file?	Yes/No
If the images are not blended, do the images and masks overlay correctly?	Yes/No

6.5.1 Imagery Sample Procedure

Step	Action	Procedure and Notes
1	Overlay the KML files from ArcMap and the KML files from the catalog in Google Earth.	This will provide verification that the data on the disk matches the data in the metadata. For the Tiff files, select the newly created KML/KMZ files and open them in Google Earth.
2	Validate the continuity of the Image files.	Compare the KML files from ArcMap to the KML files from the catalog. Open the KML's (only) in Google Earth. Validate in Google Earth that these data blocks match by turning on and off. Now bring the KMZ's from the catalog directory into Google Earth and verify there are no holes in the imagery they provided.
3	Open the Shapefiles created by the Preview Procedure in ArcMap.	In ArcMap make the original dataframe layer active. Right click one of the data layer subsets and select by attributes.
4a	Query the files to ensure the resolution of the file matches the filename.	In ArcMap, copy/paste in all queries (below), verify and apply. Select "Selected" in Show. Verify any results.

4b	cont.	(("RASTER_NAM" LIKE '%quartermeter%') AND ("RES_NAM" <> '1 foot or less')) or (("RASTER_NAM" LIKE '%halfmeter%') AND ("RES_NAM" <> '0.5 meter')) or (("RASTER_NAM" LIKE '%_1m%') AND ("RES_NAM" <> '1 meter')) or (("RASTER_NAM" LIKE '%_2m%') AND ("RES_NAM" <> '2 meter')) or (("RASTER_NAM" LIKE '%_4m%') AND ("RES_NAM" <> '4 meter')) or (("RASTER_NAM" LIKE '%_8m%') AND ("RES_NAM" <> '8 meter')) or (("RASTER_NAM" LIKE '%_16m%') AND ("RES_NAM" <> '16 meter'))
5a	If masks are present, verify the masks match the given OTW file.	In ArcMap, create a data frame called "OTW and OTW Mask files" and make this data frame active. Copy or drag the separated OTW and OTW Mask files from the other data frame layers into this layer. Select by location features from the OTW shapefile that intersect the matching OTW.
5b	cont.	Open the attribute table for the data frame using the selected OTW_Shapefile. Select the option "Switch Selection" and "Show Selected". If there is nothing selected then the data matches. If there are selected images and the imagery is not 16m or have "_transition" appended to the filename (this means is blended already and doesn't need a mask) then copy the list and make a note of it in the QA spreadsheet. Repeat this step for each resolution.
6	Create thumbnails.	Run the Python script for this purpose.
7	Create a KMZ file with the thumbnails to preview the data.	If possible, remap the new thumbnail data to the thumbnail directory of the dataset, or remap the metadata to the thumbnail directory.
8	View the new KMZ data to preview the quality of the data.	Preview the color balance, cloud cover, feathering, image mask coverage, and overall quality of the scene.

6.6 Elevation Files

Requirement	Result
Does the metadata match the elevation data provided?	Yes/No
Does the data correlate/overlay the image files along the coast?	Yes/No
Are all elevation files continuous?	Yes/No

6.6.1 Elevation Sample Procedure

Step	Action	Procedure and Notes
1	Repeat the common tests.	Common tests from the General Geospatial Information and the Imagery section can be repeated here.
2	Overlay the KML Files from ArcMap and the KML files from the catalog in Google Earth.	This will provide verification that the data on the disk matches the data in the metadata. Select the newly created KML/KMZ files and open them in Google Earth.
3	Validate the continuity of the Image files.	Compare the KML files from ArcMap to the KML files from the catalog. Open the KML's (only) in Google Earth. Validate in Google Earth that these data blocks match by turning on and off. Now bring the KMZ's from the catalog directory into Google Earth and verify there are no holes in the imagery they provided.

6.7 Features

Requirement	Result
Verify the point features are geospatially correct.	Yes/No
Verify the line features are geospatially correct.	Yes/No
Verify the areals (polygon) features are geospatially correct.	Yes/No
Verify attribution schema used is documented in DBDD or official standard.	Yes/No
Verify attribution code is accurate for each feature.	Yes/No
Verify all key points of interest listed in the DBDD were provided.	Yes/No
If used, verify the airfield points match the correct airfield.	Yes/No

6.7.1 Features Sample Procedure

Step	Action	Procedure and Notes
1	Import all of the shapefiles into ArcMap.	Search each feature section (ie. airbases, AOI, cultural features, et. al.) in the root directory for shape files needing to be brought into ArcMap. Open these files into a newly created, appropriately named data layer.
2	Scan for any points inconsistently placed.	Via ArcMap.
3	Check to ensure there are no blank "code" or key descriptor attributes.	Via scripts or ArcMap.
4	Note and validate attribution schema.	Review schema and annotation via DBDD (custom schema) or one of the standard feature attribution schemas (NFDD, FACC, SEDRIS, etc.)
5	Export map to KML.	In ArcMap, use “Map to KML” to convert the map document to KML files. Select one of the shapefile’s data frames and the output directory for the KML file. Name the KML file appropriately and save with a map output scale of 1. Repeat for each Shapefile data frame (Airbases, AOI, Cultural features)
6	Review each file in Google Earth and scan for any outliers.	In Google Earth, load the newly created KMZ’s. Scan for any points inconsistently placed. Visually check that: • Airfields match correct airfield. • Buildings are separated out. • Codes are not being repeated for incorrect features. • Overall continuity.
7	Ensure the airfields match the correct airfield names.	Visual check via KMZ or ArcMap.
8	Ensure the buildings are separated out.	Visual check via KMZ or ArcMap.
9	Ensure codes are not repeated for incorrect features	Visual check ArcMap

6.8 3D Models

Requirement	Result
Are the models in a valid OpenFlight® format of version 16+?	Yes/No
Does the model name match or is it recognizably similar to the name in DBDD?	Yes/No
Does model snap shot in the DBDD match the model itself?	Yes/No
Do the articulated parts in the model and DBDD match correctly?	Yes/No
Are the correct 'max polygons' listed in DBDD?	Yes/No
Do the lights match what is listed in the DBDD? Are they correct?	Yes/No
Are there any noticeable problems with geometry or textures in any of the LODs?	Yes/No
Are there repeated models (T/M/S)?	Yes/No
Are there repeated models (with SAME textures)?	Yes/No
Are there repeated models (FILENAME)?	Yes/No

6.8.1 Moving Models Sample Procedure

Step	Action	Procedure and Notes
1	Check if model is supplied in OpenFlight® and opens properly in Creator.	Check for a .flt and open this file in Presagis Creator.
2	Does the model name match or is it recognizably similar to the name in DBDD?	Open the DBDD, find the model in the document, and compare names.
3	Does the model snapshot in the DBDD match the model itself?	Open DBDD, find the model in the document, and compare geometry/textures.
4	Validate the articulated parts in the model and DBDD.	Find the articulated parts in model using the DOF Viewer in Creator. If articulated parts are present, the viewer will come up and list the parts, otherwise you will get the message that says "No DOFs in Scene."
5	Does polygon count match the DBDD?	Find the model in the DBDD and find the listed polygon count for that model. Compare with the polygon count in the model as reported by Creator.

6	Do lights match what is listed in the DBDD? Are they correct?	Find the model in the DBDD and find the listed required lights for that model. In Creator, expand down into the model's hierarchy to find the light points. Open the light point attributes window. This should give the name of the type of light that will help match to what is listed in the DBDD.
7	Are there any noticeable problems with geometry in any of the LODs?	In Creator, flip through the LODs to visually check for missing geometry.
8	Are there repeated models (Type/Model/Series)?	Flag item as appropriate.
9	Are there repeated models (with SAME textures)?	Flag item for possible deletion.
10	Are there repeated models (FILENAME)?	Flag item for possible deletion.
11	Make note of model residence for easy future locating.	Just make note here of where the model currently resides.

6.9 3D Airfields

Requirement	**Result**
Is there a flat earth OpenFlight® version 16+ of the airfield model?	Yes/No
Are markings present and correct as specified by the DBDD?	Yes/No
Does the airfield name match what is listed in the DBDD?	Yes/No
Does the OpenFlight® model have a shapefile associated with it?	Yes/No
Do the lights match what is listed in the DBDD? Are they correct?	Yes/No
Are geometry and textures without problems in all of the LODs?	Yes/No
Does this airfield model correctly represent actual airfield?	Yes/No

6.9.1 3D Airfields Sample Procedure

Step	**Action**	**Procedure and Notes**

1	Is there a Flat Earth version of the OpenFlight® airfield model?	Check for a .flt file and open this file in Presagis's Creator. Open the 'Header Attributes' window and select the 'Projection' tab. Confirm that it reads 'Flat Earth' in the Map Projection section.
2	Are any markings missing or incorrect as specified by the DBDD?	In Creator, visually check the markings for correctness.
3	Does the model name match or is it recognizably similar to the name in model description within the DBDD?	Open the DBDD, find the model in the document and compare names. You may have to search the document thoroughly to conclude.
4	Do lights match what is listed in the DBDD? Are they correct?	Find the model in the DBDD and find the listed required lights for that model. In Creator, expand down into the model's hierarchy to find the light points. Open the light point attributes window. This should give the name of the type of light that will help match to what is listed in the DBDD.
5	Are there any noticeable problems with geometry or textures in any of the LODs?	In Creator, flip through the LODs to visually check for missing geometry.
6	Does this airfield model correctly represent the actual airfield?	Look up the airfield diagram for the airfield to check its validity.

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Appendix A Initial Data Production and NPSI Dataset Overview

The intent of the NPSI dataset is to provide database development teams with data that has been prepared for simulation applications and can be archived for use on other programs. This data will be in "typical" formats that can be used with existing database generation tools.

The generation of the NPSI data includes the typical manipulation of source data that is involved in most database projects. One primary difference is that the final versions of the various data formats will be collected and documented for distribution to subsequent database efforts.

A.1 Terrain Elevation Data

Terrain data is normally in the form of a grid of elevation values. For example, National Geospatial Intelligence Agency (NGA) Digital Terrain Elevation Data (DTED) is a grid of values within a geo-cell. For Level 1 DTED, the grid points are spaced at three arc/seconds of latitude and longitude (~100 meters). This provides a 1201 x 1201 grid of elevations for each geo-cell. DTED Level 2 has a grid spacing of 1 arc/second or ~30 meters. There is currently very little Level 2 coverage. In general, the terrain data will require modification. Possible actions include correcting any voids in the data (these are rare in current data) and ensuring that edge conditions match at the boundaries with neighboring geo-cells. It may also be desirable to flatten areas for the inclusion of modeled features such as airfields. Any thinning that is required for providing a terrain skin within the polygon limitations of the target image generator are not desired and are not to be included in these refinements. There will be references to the final polygon skin in other parts of the NPSI data. Subsequent versions of the database may be able to make use of more of the original terrain data either because of higher Image Generator (IG) performance or because their version of the mission allows a different polygon allowance mix.

A.2 Feature Data

Feature data describes the cultural and natural features that are on the terrain. The most common formats for feature data are ESRI Shapefile format, NGA Digital Feature Analysis Data (DFAD), and Vector Map (VMAP). However, DFAD and VMAP are currently being replaced by other formats. Shapefiles are separated into three types of features: point features, linear features, and area features. These are described in a data format that includes locating points (lat./long.), elevation, and feature identification codes. In the normal database production process, the feature data is used in combination with the terrain elevation data to produce a terrain skin populated with features.

The significant problem with feature data in current simulation applications stems from the lack of correlation between the defined features and the images of those features in satellite imagery or aerial photography as discussed in Section A.3. These discrepancies occur for a number of reasons. In some cases, the feature data approximates the real-world feature (e.g., a curved road is represented as a series of segments). In other cases, the position of the feature is not accurate (the DFAD/VMAP specification calls for features to be within 50 feet of their actual location). In cases of legacy data, the feature data was collected some time ago and is no longer valid. Correcting these discrepancies may require a great deal of adjustment depending on the database fidelity requirements. In general, these adjustments to the feature location, content, and shape must be done by hand. The task does not currently lend itself to automated tools. It is important to the NPSI data concept that any of these manual adjustments to the feature data be captured in the refined version of the feature data, in an open format, so that the manual adjustments are not repeated in subsequent production efforts. NEC attribution is to be used as much as possible to identify feature data.

A.3 Imagery Data

Many current simulation applications make use of satellite and/or aerial photography as texture maps to represent the real-world terrain skin more accurately. The first step is to assemble the raw imagery. Raw imagery can be provided from government sources or can be purchased from commercial suppliers. Once obtained, the individual images must be assembled into a single image mosaic that covers the database area. This includes such complex tasks as ortho-rectification and mosaicing. Ortho-rectification is the process of adjusting the images so the images appear to have been photographed from directly above and that terrain shapes and elevations are compensated. Mosaicing the images together into a single image by blending across edges, compensating for differences in the images (time of year, clouds), and compensating for different image resolutions.

The resolution required for the geo-specific texture may differ within the database depending on the mission parameters. When operating close to the ground (e.g., takeoff and landing, low-level navigation), texel resolution of less than or equal to one meter may be required. At higher altitudes, the texture map resolution can be greater because the texture level of detail process (e.g., MIP mapping) will filter out the higher resolution versions of the texels. It will be beneficial to the NPSI data concept to process the source imagery at the highest resolution possible so that future applications will have access to this data even though the initial supplier's platform or mission may not require or support the fidelity. The technical and economic implications of asking the supplier to provide higher resolution imagery than is required will need to be considered.

Despite the availability of a number of tools for the manipulation of source imagery, the task is complex and tends to be labor intensive. It is important to both production efficiency and correlation that the resulting mosaic image (at the highest practical resolution) be included in the NPSI data for use on subsequent versions of the database.

A.4 Models

3D models are an essential part of any database. A feature model library may be used to represent three-dimensional features. A feature model library is a collection of conventional models of typical features (e.g. factories, houses, power plants, etc.) that can be positioned on the terrain, normally to represent point features. In addition to the feature model library, 3D models will also be used to represent specific features in the database. These include high detail areas such as airfields and targets, unique features or landmarks used for navigation purposes, and dynamic target models such as aircraft and vehicles. For any given database production effort, the 3D models will be a combination of newly developed features (e.g., the home airfield) and models adapted from previous programs (e.g., target aircraft). In adapting previous models, it may be necessary to make adjustments to account for the overall visual system performance. This includes the resolution of the display system and the performance of the IG.

In addition to the basic models, it may also be necessary to include several alternate versions of the modeled feature. These typically include damaged and destroyed versions that can be selected when appropriate. Other model characteristics may include alternate polygons or textures for sensor effects (e.g., hot spots) that are activated when appropriate to the mission scenario. Each model may also include several levels of detail. These are intended to represent the feature with fewer and fewer polygons at greater distances. Level of detail and scaling is sometimes used to make the feature more visible at long range (e.g. by increasing the contrast with the background).

Both the construction of new models and the adaptation of legacy models are primarily manual tasks. It is again important that these value added efforts be captured in the NPSI data in an open format, so that these manual tasks are not repeated in subsequent production efforts. It may be necessary to make adjustments in order for the models to be optimized for alternate image generators and/or platform missions. The format of the 3D models and accompanying documentation are designed to facilitate this optimization.

Appendix B Run-time Database Production Concepts

This effort includes the typical production process that would be employed on any large database effort. The native database tools for the initial target IG will process the corrected and correlated source data discussed in the previous sections. The design factors that are incorporated into the database are based on the performance of the IG (e.g., number of polygons, amount of texture, texture resolution, etc.) and the mission(s) of the individual platforms (e.g., low level navigation). Many aspects of the database that are implemented in this step are eventually incorporated into the final NPSI data.

B.1 Terrain Generation

The terrain elevation and terrain feature data are combined to generate the terrain skin and associated features. In most cases, the IG performance requires that both the terrain and feature data be culled to limit the number of polygons to the amount that can be rendered at the required update rate. The resulting terrain skin polygons take the form of either a regular mesh or a triangulated irregular network (TIN) depending on the IG architecture. The levels of detail contained in the terrain structure, and the method of switching from one level to the next, depends on the IG performance and features. A significant part of the terrain design includes the degree to which the features are allowed to influence the terrain skin. Forcing the terrain to incorporate river valleys, road geometry, complex coastlines, and other similar features provides a much more realistic looking database at the expense of a large number of polygons that are not available for other features such as 3D models.

B.2 Polygonal Feature

Changes made to the terrain to accommodate features are captured to the maximum extent possible when elevation data is exported to the DTED or GeoTIFF format used to represent the final NPSI data. Several processes are used to generate a polygonal representation of feature data. Polygons for some features are constructed by third party tools as part of the terrain skinning process. These include linear features such as roads that are defined as a series of points that mark the centerline of the road. The codes with the road lineal indicate the type of road that is intended (e.g., width, number of lanes, etc.). Tools are used to create the required polygons in the correct positions along the terrain surface. As part of the polygon generation, appropriate texture maps are assigned to the road surface. Depending on the application for the database, the tools to incorporate additional characteristics into the road in order to make it trafficable (as opposed to a simple road that is only viewed from an aircraft) may also be necessary. Adding roadside shoulders and berms and/or cutting the road into hillsides require more polygons than the simple 2D road.

Point features may be converted to polygonal representations by referencing a feature model library. The models may be selected randomly so that not all of the houses or factories are identical. It is sometimes necessary to customize the feature model library for the part of the world represented by the database. A village or church features identified by the DFAD/VMAP point feature may have a different appearance depending on the local culture.

Some point features require that a model be adjusted to the terrain. A good example is a bridge. Typically, the feature model library includes a bridge section or prototype. The tools then adapt the bridge model to the specific application. This includes rotating the bridge to align with the road or railroad lineal that the bridge supports, and "stretching" the bridge to meet the ends of the road or railroad. Stretching may involve actually changing the geometry of the model or repeating the bridge segment until it is long enough to cover the gap between the lineal ends. Changes to the feature data are to be captured to the maximum extent possible (e.g., attributes, coordinate changes) before exporting to the final NPSI shapefile(s).

B.3 Imagery

Satellite and/or aerial imagery for the entire database area is processed into texture maps. This may take the form of a single large map or be broken up into small sections that match the terrain tiles.

B.4 3D Models

Due to the nature of 3D models and their open formats, the separation between the source version of the model included in the NPSI data and the application specific version included in the database is less clear. All aspects of any new models generated to meet specific requirements (e.g., the home airfield) are included in the NPSI data. Exceptions may occur where changes are made (particularly deletions) in support of specific platform features that are not likely to be of use elsewhere. These might include the addition of special polygons or versions of the model to support specific sensor effects. The original version of the model may be more useful as a starting point for follow on applications and platforms. These choices are examined on a case-by-case basis.

B.5 3D Moving Models

3D moving models are dynamic models that may include one or more animations as part of the model. The NPSI data for 3D moving models incorporate all data that may be useful on other platforms, but the run-time 3D moving model may include information specific to only one platform.

B.6 Metadata

Metadata is data used to describe data including information such as source, projections, locations, licensing information, and other descriptive data specific to each data element. NAVAIR has developed a metadata schema in XML, which is defined by the *NAVAIR Portable Source Initiative Standard for Reusable Source Dataset Metadata V2.4* document.

B.7 Database Working Groups

Other than the need to capture useful refined source data, it is assumed that the database production process will be typical of any government procurement. This typically includes a number of Database Working Group meetings where the progress of the production is reviewed with representatives from the user community. These reviews provide the opportunity for the users to see how various features and terrain areas are represented. These reviews also provide an opportunity for the database design team to gather useful inputs from the users as to the locations and/or appearance of significant features. At the early review meetings, it is common to demonstrate representative features and terrain areas for approval. At subsequent meetings, larger and larger sections of the database are demonstrated until the final product is available. The database should be viewed with the display device that is used in the final application and when possible viewed in the simulator device.

Appendix C Recommended OpenFlight® Airport Hierarchy

The goal of NPSI for the 3D Airfield Models is to create an interchange format that allows for automated restructuring of the data. In order to achieve this goal, a standard format must be agreed upon throughout industry. To initiate discussion on this topic, an initial structure has been compiled. All comments are welcome.

Notes and Modeling Expectations:

All polygon faces and vertexes should face the same normal direction to avoid undesired backfacing.

No concurrent vertices are desired.

No non-planar faces are desired.

No concave faces are desired.

Footprints should exist for each LOD to match that LOD's geometry.

Object nodes should contain no more than 1024 polygons. If there are >1024 polygons residing under an object node, multiple object nodes should be created. (NOT REQUIRED)

The intent of this recommended hierarchy is to simplify or automate the process of tailoring the model to a particular run-time. As such, while consistency is important, this should not drive a technical approach to modeling. However, if an implemented hierarchy deviates from this guideline, it should be consistent, documented, and lend itself to the intent of simplifying the aggregation and disaggregation of elements.

C.1 Individual Building File Hierarchy Structure

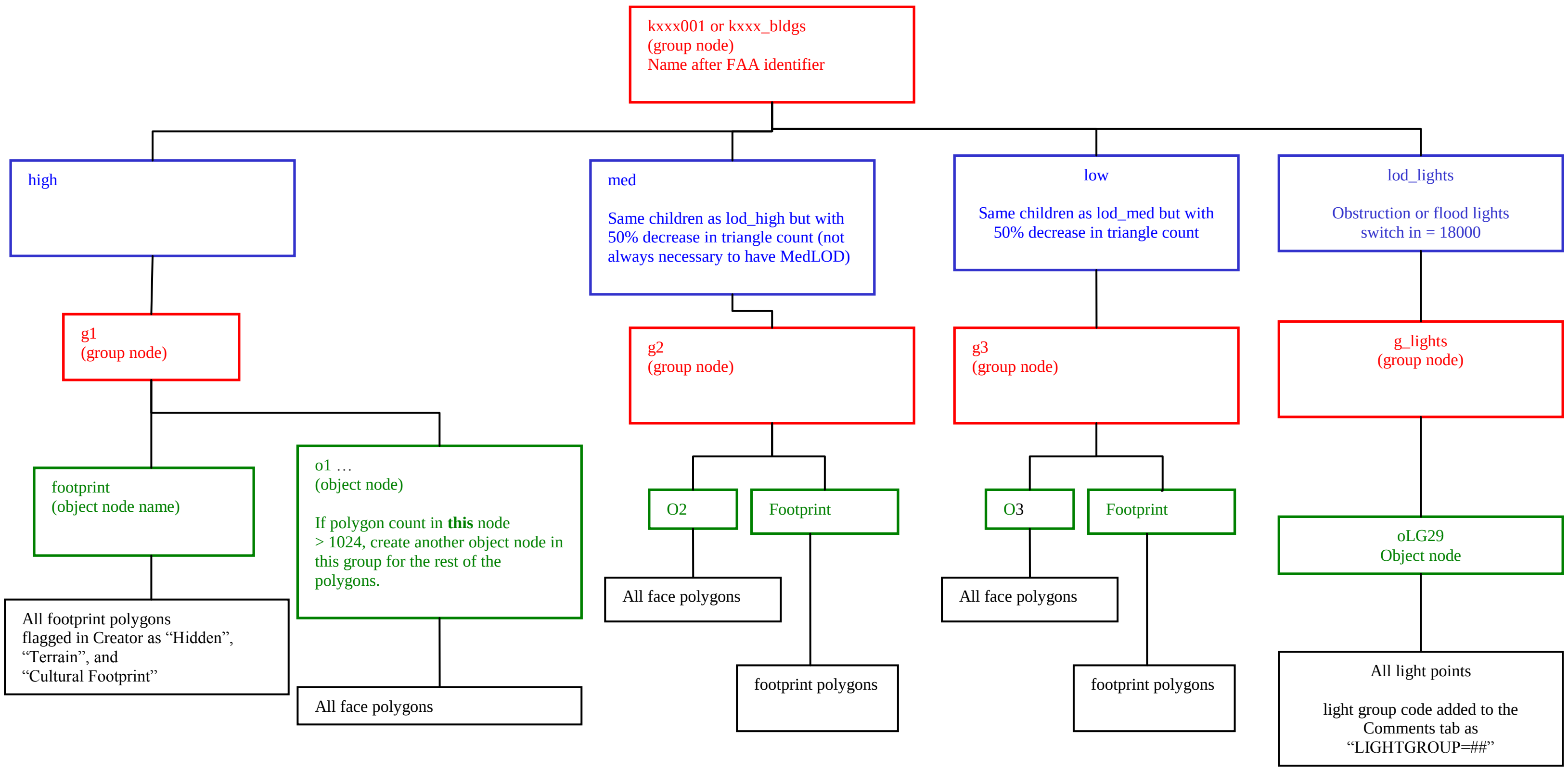

Figure 2 OpenFlight® building hierarchy example.

C.2 Runway File Hierarchy Structure

Comment field at the root level (db) should include the year of the rendered airport.

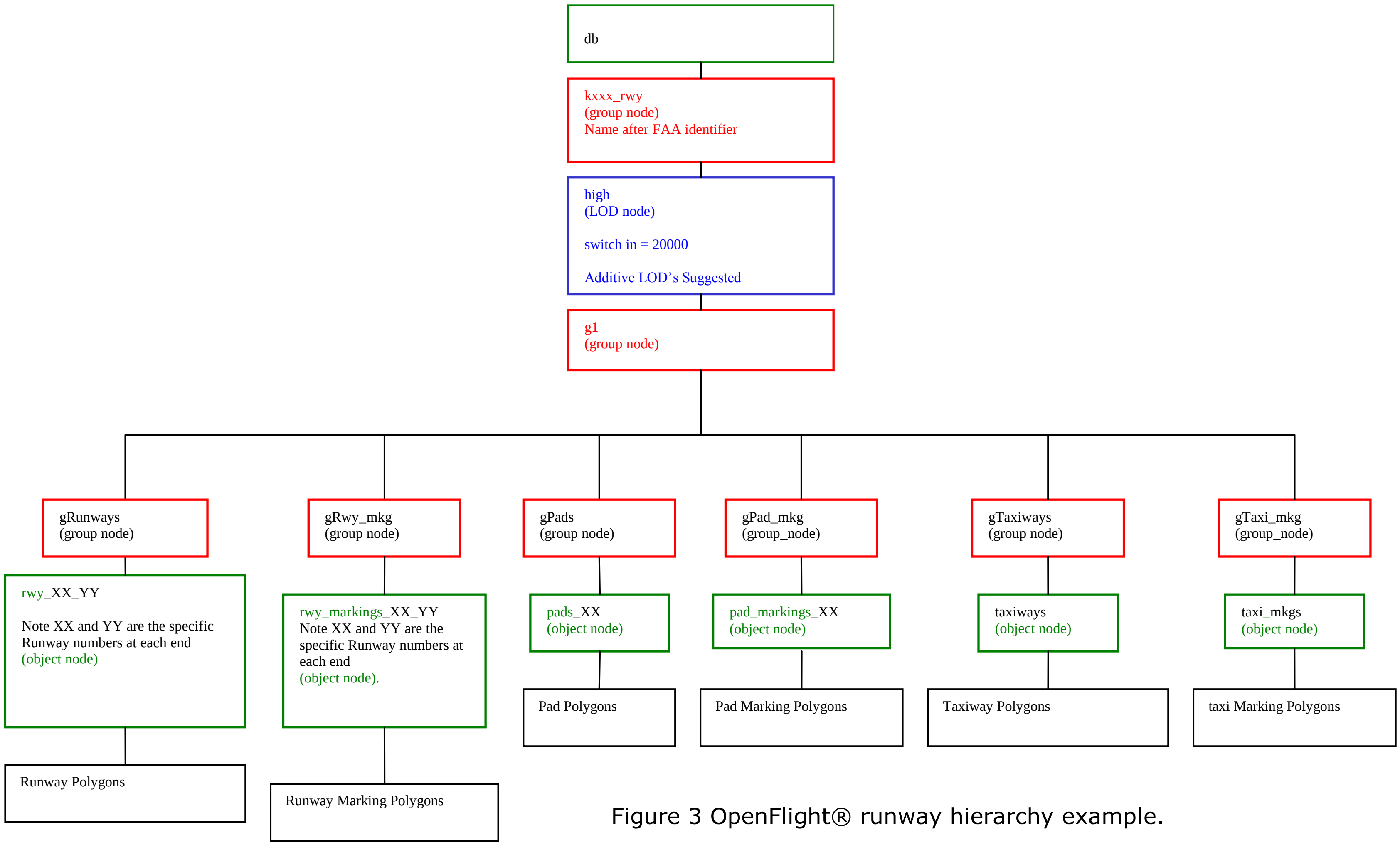

Figure 3 OpenFlight® runway hierarchy example.

C.3 Airport Lights File Hierarchy Structure

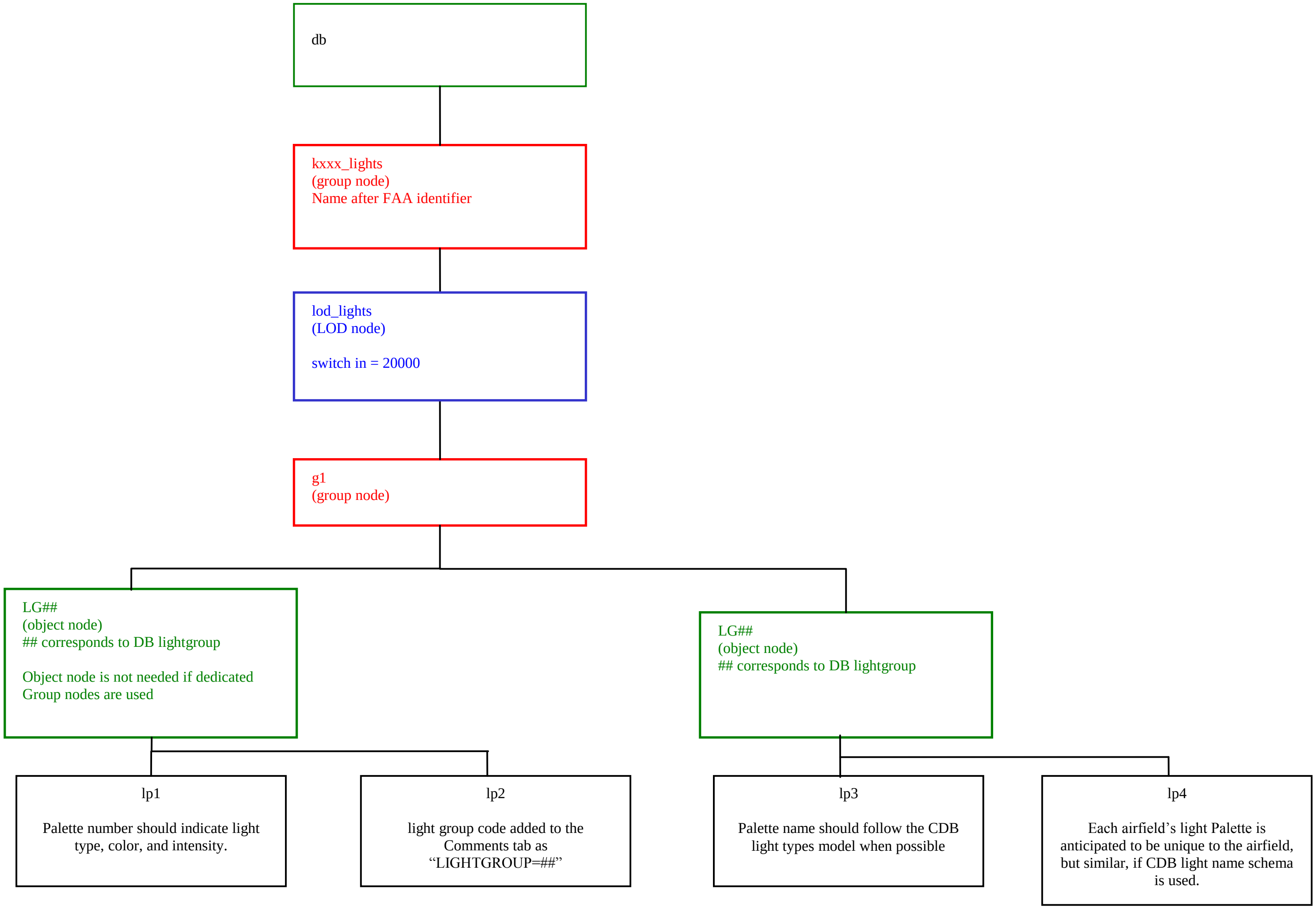

Figure 4 OpenFlight® airport lights hierarchy example.

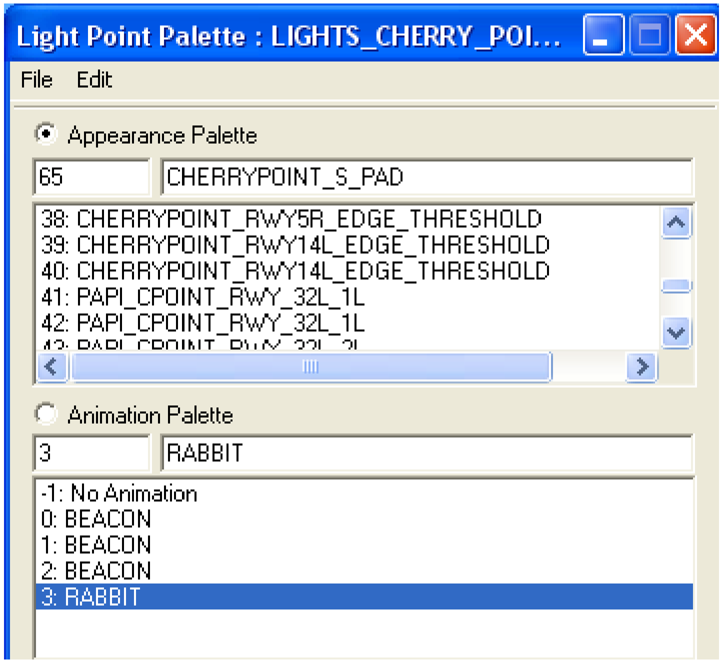

Figure 5 Airport light palette example with descriptive naming convention.

C.4 Foot-To-Go Hierarchy Structure

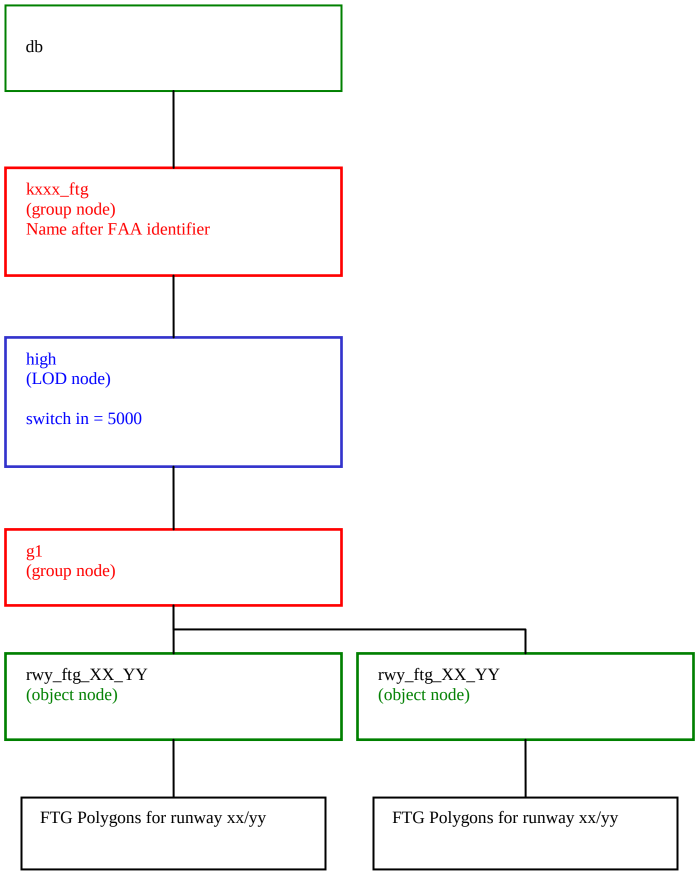

Figure 6 OpenFlight® foot-to-go hierarchy example.

C.5 Master File Preview Hierarchy Structure

This file is to be used for rapid viewing of the Airfield and is not anticipated to be run-time formatted. Nested External references can yield poor performance. This file is not required.

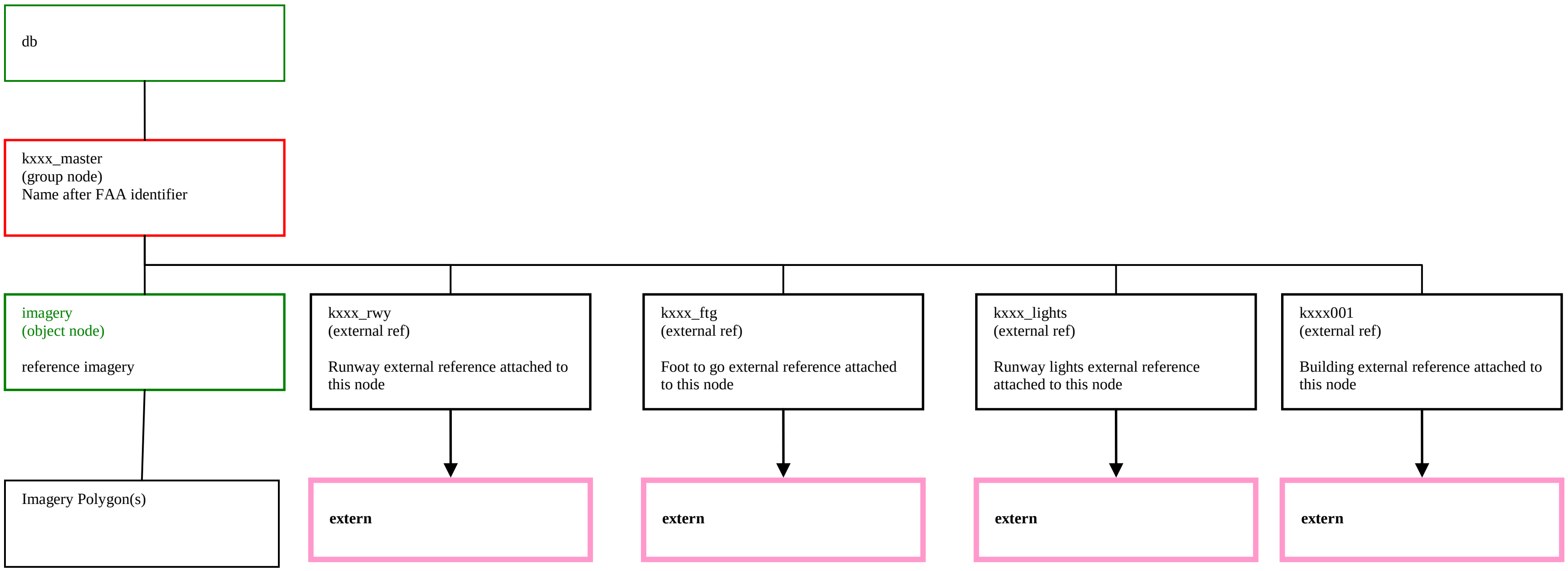

Figure 7 OpenFlight® master file hierarchy example.

Appendix D CDB v 2.1 Light Point Excerpt

This section shows the current format for light points “Airfield Extract” as noted from the Common Database (CDB) Specification for USSOCOM, Report N61339-01-D-0725/0003 – G005.

It is desired that the standard names for the Light Point Palette for both appearance and animation are representative of the lists within Appendix D. The Light point palette is a searchable entry within the model and with common naming; a more interchangeable light point setup can be used.

See next pages for the excerpt.

Light Hierarchy	Light Code	Description	Intensity (normalized)	Color (normalized RGB)	Directionality (type)	Width_Hor (degrees)	Width_Vert (degrees)	Intensity_Res (normalized)	Frequency (Hz)	Duty_Cycle (normalized)
Airport_Lighting	274	Generic Airport Lighting	0.9	1 | 1 | 1	Omni	---	---	---	---	---
Apron	275	Generic Apron light	0.9	1 | 1 | 1	Omni	---	---	---	---	---
Entrance_Light	276	Apron entrance light from runway or taxiway	0.9	1 | 1 | 1	Omni	---	---	---	---	---
Flood_Light	277	Flood light to illuminated the Apron	0.9	1 | 1 | 1	Omni	---	---	---	---	---
Beacon	278	Generic Beacon light	0.9	1 | 1 | 1	Omni	---	---	---	0.33	0.33
ID_Beacon_Light	279	Identification Beacon light	0.9	1 | 1 | 1	Omni	---	---	---	0.33	0.33
White_Rotating_2sec_Light	280	White 2 sec interval Rotating Beacon	0.9	1 | 1 | 1	Omni	---	---	---	0.5	0.33
White_Rotating_3sec_Light	281	White 3 sec interval Rotating Beacon	0.9	1 | 1 | 1	Omni	---	---	---	0.33	0.33
White_Rotating_5sec_Light	282	White 5 sec interval Rotating Beacon	0.9	1 | 1 | 1	Omni	---	---	---	0.2	0.33
Green_Rotating_2sec_Light	283	Green 2 sec interval Rotating Beacon	0.9	0 | 1 | 0	Omni	---	---	---	0.5	0.33
Green_Rotating_3sec_Light	284	Green 3 sec interval Rotating Beacon	0.9	0 | 1 | 0	Omni	---	---	---	0.33	0.33
Green_Rotating_5sec_Light	285	Green 5 sec interval Rotating Beacon	0.9	0 | 1 | 0	Omni	---	---	---	0.2	0.33
White_Flashing_2sec_Light	286	White 2 sec interval Flashing Beacon	0.9	1 | 1 | 1	Omni	---	---	---	0.5	0.33
White_Flashing_3sec_Light	287	White 3 sec interval Flashing Beacon	0.9	1 | 1 | 1	Omni	---	---	---	0.33	0.33
White_Flashing_5sec_Light	288	White 5 sec interval Flashing Beacon	0.9	1 | 1 | 1	Omni	---	---	---	0.2	0.33
Green_Flashing_2sec_Light	289	Green 2 sec interval Flashing Beacon	0.9	0 | 1 | 0	Omni	---	---	---	0.5	0.33
Green_Flashing_3sec_Light	290	Green 3 sec interval Flashing Beacon	0.9	0 | 1 | 0	Omni	---	---	---	0.33	0.33
Green_Flashing_5sec_Light	291	Green 5 sec interval Flashing Beacon	0.9	0 | 1 | 0	Omni	---	---	---	0.2	0.33
Docking_Sytem	292	Generic docking system light	0.9	1 | 0.6 | 0	Omni	---	---	---	---	---
Amber_Light	293	Amber Docking System light	0.9	1 | 0.6 | 0	Omni	---	---	---	---	---
Green_Light	294	Green Docking System light	0.9	0 | 1 | 0	Omni	---	---	---	---	---
Red_Light	295	Red Docking System light	0.9	1 | 0 | 0	Omni	---	---	---	---	---
Obstruction	296	Red light indicating the presence of an object which is dangerous to an aircraft in flight.	0.85	1 | 0 | 0	Omni	---	---	---	0.5	0.33
Flashing_Light	297	Red Obstruction flashing light	0.85	1 | 0 | 0	Omni	---	---	---	0.5	0.33
Hi_Intensity_Light	298	Red Hi-Intensity obstruction light	0.9	1 | 0 | 0	Omni	---	---	---	0.5	0.33
Runway	299	Generic Runway lights	0.9	1 | 1 | 1	Omni	---	---	---	---	---
Approach_System	300	Generic Airport Approach Lighting Systems	0.9	1 | 1 | 1	Dir	75	75	---	---	---
Barrette	301	Barrette light	0.9	1 | 1 | 1	Dir	75	75	---	---	---
Red_Light	302	Red barrette light	0.9	1 | 0 | 0	Dir	75	75	---	---	---
White_Light	303	White barrette light	0.9	1 | 1 | 1	Dir	75	75	---	---	---
Circling_Guidance_Light	304	Circling Guidance Light which helps on a circling approach	0.9	1 | 1 | 1	Dir	75	75	---	---	---
Landing_Marking_Light	305	Marking Lights that illuminate any markings that need to be visible on the runway in low visibility	0.9	1 | 1 | 1	Omni	---	---	---	---	---
Lead-in_Light	306	LDIN - lead-in light system lights	0.9	1 | 1 | 1	Dir	50	110	---	---	---
Optical_Landing_System	307	Optical landing system lights	0.9	1 | 1 | 1	Omni	---	---	---	---	---
High_Intensity_Light	308	High intensity approach light	0.9	1 | 1 | 1	Dir	75	75	---	---	---
Low_Intensity_Light	309	Low intensity approach light	0.85	1 | 1 | 1	Dir	75	75	---	---	---
ODAL_Light	310	Omni directional approach light	0.9	1 | 1 | 1	Omni	---	---	---	---	---

Light Hierarchy	Light Code	Description	Intensity (normalized)	Color (normalized RGB)	Directionality (type)	Width_Hor (degrees)	Width_Vert (degrees)	Intensity_Res (normalized)	Frequency (Hz)	Duty_Cycle (normalized)
PAPI	311	Generic Precision approach path indicator. Provides visual glide slope indication using a single row of two or four light	0.95	1 | 1 | 1	Dir	75	10	---	---	---
APAPI_Close_Light	312	Abbreviated Precision Approach Path Indicator closest to runway	0.95	1 | 1 | 1	Dir	75	10	---	---	---
APAPI_Far_Light	313	Abbreviated Precision Approach Path Indicator farthest to runway	0.95	1 | 1 | 1	Dir	75	10	---	---	---
TypeA_Light	314	PAPI A (farthest from runway)	0.95	1 | 1 | 1	Dir	75	10	---	---	---
TypeB_Light	315	PAPI B (3rd from runway)	0.95	1 | 1 | 1	Dir	75	10	---	---	---
TypeC_Light	316	PAPI C (2rd from runway)	0.95	1 | 1 | 1	Dir	75	10	---	---	---
TypeD_Light	317	PAPI D (Closest from runway)	0.95	1 | 1 | 1	Dir	75	10	---	---	---
RAIL_Light	318	Runway alignment indicator lights	0.9	1 | 1 | 1	Dir	75	75	---	---	---
REIL_Light	319	Runway End Identifier Lights	0.95	1 | 1 | 1	Dir	75	75	---	2	0.33
SFL	320	Generic Sequence Flashing Lights	0.9	1 | 1 | 1	Dir	75	75	---	2	0.1
CAT-I	321	Approach Lighting System with sequenced flashing	0.9	1 | 1 | 1	Dir	75	75	---	2	0.1
CAT-II	322	Approach Lighting System with sequenced flashing	0.9	1 | 1 | 1	Dir	75	75	---	2	0.1
CALVERT-I	323	Approach Lighting System with sequenced flashing	0.9	1 | 1 | 1	Dir	75	75	---	2	0.1
CALVERT-II	324	Approach Lighting System with sequenced flashing	0.9	1 | 1 | 1	Dir	75	75	---	2	0.1
ALSF-1	325	Approach Lighting System with sequenced flashing	0.9	1 | 1 | 1	Dir	75	75	---	2	0.1
ALSF-II	326	Approach Lighting System with sequenced flashing	0.9	1 | 1 | 1	Dir	75	75	---	2	0.1
SSALF	327	Approach Lighting System with sequenced flashing	0.9	1 | 1 | 1	Dir	75	75	---	2	0.1
SSALR	328	Approach Lighting System with sequenced flashing	0.9	1 | 1 | 1	Dir	75	75	---	2	0.1
MALSF	329	Approach Lighting System with sequenced flashing	0.9	1 | 1 | 1	Dir	75	75	---	2	0.1
MALSR	330	Approach Lighting System with sequenced flashing	0.9	1 | 1 | 1	Dir	75	75	---	2	0.1
VASI	331	Generic Visual Approach Slope Indicator System (VASI)	0.9	1 | 1 | 1	Dir	75	10	---	---	---
2Bar	332	2 Bar Component VASI	0.9	1 | 1 | 1	Dir	75	10	---	---	---
First_Light	333	2-Bar VASIS (1st bar closest to threshold)	0.9	1 | 1 | 1	Dir	75	10	---	---	---
Second_Light	334	2-Bar VASIS (2nd bar farthest from threshold)	0.9	1 | 1 | 1	Dir	75	10	---	---	---
3Bar	335	3 Bar component VASI	0.9	1 | 1 | 1	Dir	75	10	---	---	---
First_Light	336	3-Bar VASIS (1st bar closest to threshold)	0.9	1 | 1 | 1	Dir	75	10	---	---	---
Second_Light	337	3-Bar VASIS (2nd bar, In between 1st and 3rd)	0.9	1 | 1 | 1	Dir	75	10	---	---	---
Third_Light	338	3-Bar VASIS (3rd bar farthest from threshold)	0.9	1 | 1 | 1	Dir	75	10	---	---	---
LCVASI_Light	339	Low-cost VASI light	0.9	1 | 1 | 1	Dir	75	10	---	---	---
TypeP_Light	340	PVASI pulsating light	0.9	1 | 1 | 1	Dir	75	10	---	---	---

Light Hierarchy	Light Code	Description	Intensity (normalized)	Color (normalized RGB)	Directionality (type)	Width_Hor (degrees)	Width_Vert (degrees)	Intensity_Res (normalized)	Frequency (Hz)	Duty_Cycle (normalized)
TypeT	341	Generic T Shaped VASI (T-VASIS)	0.9	1 | 1 | 1	Dir	75	10	---	---	---
Fly-down_Light	342	Fly Down lights	0.9	1 | 1 | 1	Dir	75	7	---	---	---
Wing_Bar_Light	343	T-VASIS wing bar light	0.9	1 | 1 | 1	Dir	75	10	---	---	---
2.50_Degree	344	2.50 degree T-VASI	0.9	1 | 1 | 1	Dir	75	2.5	---	---	---
Fly-Up1_Light	345	T-VASIS Fly-up 1 (closest to Wing Bar) for 2.5 degree Glide slope	0.9	1 | 1 | 1	Dir	75	2.5	---	---	---
Fly-Up2_Light	346	T-VASIS Fly-up 2 (closest to Wing Bar) for 2.5 degree Glide slope	0.9	1 | 1 | 1	Dir	75	2.4166	---	---	---
Fly-Up3_Light	347	T-VASIS Fly-up 3 (farthest to Wing Bar) for 2.5 degree Glide slope	0.9	1 | 1 | 1	Dir	75	2.3334	---	---	---
2.75_Degree	348	2.75 degree T-VASI	0.9	1 | 1 | 1	Dir	75	2.75	---	---	---
Fly-Up1_Light	349	T-VASIS Fly-up 1 (closest to Wing Bar) for 2.7 degree Glide slope	0.9	1 | 1 | 1	Dir	75	2.75	---	---	---
Fly-Up2_Light	350	T-VASIS Fly-up 2 (closest to Wing Bar) for 2.7 degree Glide slope	0.9	1 | 1 | 1	Dir	75	2.6666	---	---	---
Fly-Up3_Light	351	T-VASIS Fly-up 3 (farthest to Wing Bar) for 2.7 degree Glide slope	0.9	1 | 1 | 1	Dir	75	2.5834	---	---	---
3.00_Degree	352	3.00 degree T-VASI	0.9	1 | 1 | 1	Dir	75	3	---	---	---
Fly-Up1_Light	353	T-VASIS Fly-up 1 (closest to Wing Bar) for 3.0 degree Glide slope	0.9	1 | 1 | 1	Dir	75	3	---	---	---
Fly-Up2_Light	354	T-VASIS Fly-up 2 (closest to Wing Bar) for 3.0 degree Glide slope	0.9	1 | 1 | 1	Dir	75	2.9166	---	---	---
Fly-Up3_Light	355	T-VASIS Fly-up 3 (farthest to Wing Bar) for 3.0 degree Glide slope	0.9	1 | 1 | 1	Dir	75	2.8334	---	---	---
3.25_Degree	356	3.25 degree T-VASI	0.9	1 | 1 | 1	Dir	75	3.25	---	---	---
Fly-Up1_Light	357	T-VASIS Fly-up 1 (closest to Wing Bar) for 3.25 degree Glide slope	0.9	1 | 1 | 1	Dir	75	3.25	---	---	---
Fly-Up2_Light	358	T-VASIS Fly-up 2 (closest to Wing Bar) for 3.25 degree Glide slope	0.9	1 | 1 | 1	Dir	75	3.1666	---	---	---
Fly-Up3_Light	359	T-VASIS Fly-up 3 (farthest to Wing Bar) for 3.25 degree Glide slope	0.9	1 | 1 | 1	Dir	75	3.0834	---	---	---
3.50_Degree	360	3.5 degree T-VASI	0.9	1 | 1 | 1	Dir	75	3.5	---	---	---
Fly-Up1_Light	361	T-VASIS Fly-up 1 (closest to Wing Bar) for 3.5 degree Glide slope	0.9	1 | 1 | 1	Dir	75	3.5	---	---	---
Fly-Up2_Light	362	T-VASIS Fly-up 2 (closest to Wing Bar) for 3.5 degree Glide slope	0.9	1 | 1 | 1	Dir	75	3.4166	---	---	---
Fly-Up3_Light	363	T-VASIS Fly-up 3 (farthest to Wing Bar) for 3.5 degree Glide slope	0.9	1 | 1 | 1	Dir	75	3.3334	---	---	---
3.75_Degree	364	3.75 degree T-VASI	0.9	1 | 1 | 1	Dir	75	3.75	---	---	---
Fly-Up1_Light	365	T-VASIS Fly-up 1 (closest to Wing Bar) for 3.75 degree Glide slope	0.9	1 | 1 | 1	Dir	75	3.75	---	---	---
Fly-Up2_Light	366	T-VASIS Fly-up 2 (closest to Wing Bar) for 3.75 degree Glide slope	0.9	1 | 1 | 1	Dir	75	3.6666	---	---	---
Fly-Up3_Light	367	T-VASIS Fly-up 3 (farthest to Wing Bar) for 3.75 degree Glide slope	0.9	1 | 1 | 1	Dir	75	3.5834	---	---	---
4.00_Degree	368	4.00 degree T-VASI	0.9	1 | 1 | 1	Dir	75	4	---	---	---
Fly-Up1_Light	369	T-VASIS Fly-up 1 (closest to Wing Bar) for 4.0 degree Glide slope	0.9	1 | 1 | 1	Dir	75	4	---	---	---
Fly-Up2_Light	370	T-VASIS Fly-up 2 (closest to Wing Bar) for 4.0 degree Glide slope	0.9	1 | 1 | 1	Dir	75	3.9166	---	---	---
Fly-Up3_Light	371	T-VASIS Fly-up 3 (farthest to Wing Bar) for 4.0 degree Glide slope	0.9	1 | 1 | 1	Dir	75	3.8334	---	---	---

Light Hierarchy	Light Code	Description	Intensity (normalized)	Color (normalized RGB)	Directionality (type)	Width_Hor (degrees)	Width_Vert (degrees)	Intensity_Res (normalized)	Frequency (Hz)	Duty_Cycle (normalized)
Centerline	372	Generic Centerline runway light	0.9	1 | 1 | 1	Bi-Dir	75	75	---	---	---
Red_Light	373	Unidirectional Red centerline light	0.9	1 | 0 | 0	Dir	75	75	---	---	---
White_Light	374	Unidirectional White centerline light	0.9	1 | 1 | 1	Dir	75	75	---	---	---
White_White_Light	375	Bidirectional White centerline light	0.9	1 | 1 | 1	Bi-Dir	75	75	---	---	---
White_Red_Light	376	White-Red centerline light	0.9	1 | 1 | 1	Bi-Dir	75	75	---	---	---
Edge	377	Generic Runway Edge lights	0.9	1 | 1 | 1	Bi-Dir	180	180	---	---	---
White_Light	378	Unidirectional White Edge light	0.9	1 | 1 | 1	Dir	180	180	---	---	---
Amber_Light	379	Unidirectional Amber Edge light	0.9	1 | 0.6 | 0	Dir	180	180	---	---	---
Red_Light	380	Unidirectional Red Edge light	0.9	1 | 0 | 0	Dir	180	180	---	---	---
Blue_Light	381	Unidirectional Blue Edge light	0.9	0 | 0 | 1	Dir	180	180	---	---	---
White_White_Light	382	Bidirectional White Edge light	0.9	1 | 1 | 1	Bi-Dir	180	180	---	---	---
White_Amber_Light	383	White-Amber Edge light	0.9	1 | 1 | 1	Bi-Dir	180	180	---	---	---
White_Red_Light	384	White-Red Edge light	0.9	1 | 1 | 1	Bi-Dir	180	180	---	---	---
White_Blue_Light	385	White-Blue Edge light	0.9	1 | 1 | 1	Bi-Dir	180	180	---	---	---
Amber_Amber_Light	386	Bidirectional Amber Edge light	0.9	1 | 0.6 | 0	Bi-Dir	180	180	---	---	---
Amber_Red_Light	387	Amber-Red Edge light	0.9	1 | 0.6 | 0	Bi-Dir	180	180	---	---	---
Amber_Blue_Light	388	Amber-Blue Edge light	0.9	1 | 0.6 | 0	Bi-Dir	180	180	---	---	---
Blue_Red_Light	389	Blue-Red Edge light	0.9	0 | 0 | 1	Bi-Dir	180	180	---	---	---
Red_Red_Light	390	Bidirectional Red Edge light	0.9	1 | 0 | 0	Bi-Dir	180	180	---	---	---
Blue_Blue_Light	391	Bidirectional Blue Edge light	0.9	0 | 0 | 1	Bi-Dir	180	180	---	---	---
End_Wing_Light	392	Runway End Wing lights	0.9	1 | 0 | 0	Dir	180	180	---	---	---
End_Light	393	Runway End lights	0.9	1 | 0 | 0	Dir	180	180	---	---	---
Flood_Light	394	Runway flood lights	0.9	1 | 1 | 1	Omni	---	---	---	---	---
Overrun	395	Light which indicated runway over run area	0.9	1 | 0.6 | 0	Dir	150	90	---	---	---
Amber_Light	396	Amber overrun light	0.9	1 | 0.6 | 0	Dir	150	90	---	---	---
Blue_Light	397	Blue overrun light	0.9	0 | 0 | 1	Dir	150	90	---	---	---
Red_Light	398	Red overrun light	0.9	1 | 0 | 0	Dir	150	90	---	---	---
Threshold_Wing_Light	399	Threshold wing lights	0.9	0 | 1 | 0	Dir	180	180	---	---	---
Threshold_Light	400	Runway threshold lights: used to identify the landing threshold of the runway	0.9	0 | 1 | 0	Dir	180	180	---	---	---
Touchdown_Zone_Light	401	Touchdown Zone lights: used to identify the appropriate landing area on the runway after the threshold	0.9	1 | 1 | 1	Dir	180	180	---	---	---
LAHSO_Light	402	Land and hold Short Operations light: runway intersecting stop lights	0.9	1 | 0.6 | 0	Omni	---	---	---	---	---

Light Hierarchy	Light Code	Description	Intensity (normalized)	Color (normalized RGB)	Directionality (type)	Width_Hor (degrees)	Width_Vert (degrees)	Intensity_Res (normalized)	Frequency (Hz)	Duty_Cycle (normalized)
Taxiway	403	Generic Airport Taxiway lights	0.9	0 | 0 | 1	Omni	---	---	---	---	---
Apron_Entrance_Light	404	Apron Entrance light which indication area where taxi enters apron area	0.9	0 | 0 | 1	Omni	---	---	---	---	---
CAT-III_Hold_Bar_Light	405	Category III Hold bar light	0.9	0 | 1 | 0	Dir	180	180	---	---	---
Centerline	406	Generic Centerline Taxiway lights	0.9	0 | 1 | 0	Dir	90	110	---	---	---
Aligned_Light	407	Alighted light for a straight sequence of a taxiway	0.9	0 | 1 | 0	Dir	90	110	---	---	---
Curved_Light	408	Curved lights for a curved sequence of a taxiway	0.9	0 | 1 | 0	Dir	50	110	---	---	---
Edge_Light	409	Taxiway edge lights	0.9	0 | 0 | 1	Omni	---	---	---	---	---
High-speed	410	Generic Taxiway high speed area lights	0.9	1 | 0.6 | 0	Dir	50	110	---	---	---
Amber_Light	411	Amber high-speed lights	0.9	1 | 0.6 | 0	Dir	50	110	---	---	---
Green_Light	412	Green high-speed lights	0.9	0 | 1 | 0	Dir	50	110	---	---	---
Lead-on_Light	413	Green Lead-On Light associated to a Stop Bar	0.9	0 | 1 | 0	Omni	---	---	---	---	---
No-entry_Light	414	No entry zone lights	0.9	1 | 0 | 0	Omni	---	---	---	---	---
Runway_Guard	415	Runway guard lights	0.9	1 | 1 | 1	Omni	---	---	---	---	---
Stop_Bar_Light	416	Stop Bar lights	0.9	0 | 1 | 0	Dir	180	180	---	---	---
Taxiway_Clearance_Light	417	Clearance bar lights are located at "hold short" positions on taxiways in order to increase the visibility of holding position	0.9	1 | 1 | 0	Omni	---	---	---	---	---
Guard	418	Generic RGL (Runway Guard Light) is used to enhance the visibility of taxiway holding positions on an airport	0.9	1 | 1 | 1	Omni	---	---	---	---	---
Type1_Light	419	Runway Guard Light Type 1	0.9	1 | 1 | 1	Omni	---	---	---	---	---
Type2_Light	420	Runway Guard Light Type 2	0.9	1 | 1 | 1	Omni	---	---	---	---	---
Type3_Light	421	Runway Guard Light Type 3	0.9	1 | 1 | 1	Omni	---	---	---	---	---
Type4_Light	422	Runway Guard Light Type 4	0.9	1 | 1 | 1	Omni	---	---	---	---	---
Wind_Indicator_Light	423	Wind indicator light	0.9	1 | 1 | 1	Omni	---	---	---	---	---
Windsock_Light	424	Windsock light used to illuminate the windsock in poor visibility	0.9	1 | 1 | 1	Omni	---	---	---	---	---